

Distillation of Wood

Student Activity

What is this activity about? Ahmed Zewail was fascinated by the world around him. His curiosity and pursuit of the answers to his questions of the behavior of everyday things ultimately led to the greatest recognition of achievement, the Nobel Prize. As a young boy he wondered how atoms and molecules behave. He asked, "What caused matter to change state; go from solid to liquid, liquid to gas or gas to liquid? Is it true that a flammable gas is present in wood?" Ahmed knew the answers lay in experimentation. Why not take wood apart, he asked. In his first experiment, he heated pieces of wood in a test tube and observed what happened.

What does it feel like to be a scientist? You and your group will perform the same experiment that started Ahmed Zewail's career in science. Before beginning the experiment, predict the forms of matter you might produce. What changes to the wood do you predict will occur? As your group proceeds through the activity, you will have many questions about the changes in matter that are taking place. Record these questions for discussion at the end of the activity.

What Materials do I need?

Chemical splash goggles	ice water
Chemical Resistant apron	burner
2 test tubes	striker
wood splints	rubber tubing
1-hole stopper	glycerin
2-hole stopper	ring stand
2 glass bends	test tube clamp
beaker	boiling chips

(Your teacher may have stopper assemblies already prepared for your use.)

What safety precautions and disposal actions must I take?

- 1) Wear chemical splash goggles and a chemical resistant apron.
- 2) Keep the flame away from the rubber stopper and test tube clamp.
- 3) Use glycerin when attaching the rubber hose to the glass elbow.
- 4) Insert the rubber tubing all the way into the collecting test tube in the beaker of water.
- 5) Burn the remaining wood splints over the sink or a heat resistant pad.
- 6) Charred wood and ash may be disposed of in the trash.
- 7) Clear colorless liquid may be flushed down the sink.
- 8) Follow your teacher's directions for proper disposal of the tarry dark liquid.

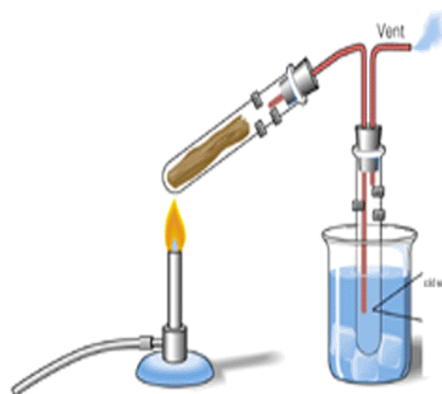


Figure 1

What procedure must I follow?

Part 1: Heating wood

- 1) Wear chemical splash goggles and a chemical resistant apron.
- 2) Place enough wood splints into the test tube to fill it.
- 3) Break the splints in half so that they fit, and leave room for a stopper to fit securely on the test tube.
- 4) Connect the test tube containing the splints to the stopper assembly and condensing tube as shown in Figure 1.
- 5) Heat the wood filled test tube using a burner with a medium flame. Keep the flame away from the rubber stopper and test tube clamp
- 6) Carefully move the burner back and forth along the length of the test tube to make sure all the wood is heated.
- 7) Observe what happens and record your observations in the table on page 3.
- 8) Try lighting the gas coming from the second glass elbow. Record your observations and questions your group has generated.
- 9) Continue heating the wood and re-light the gas coming from the 2nd glass elbow until there are several mL of liquid in the condensing test tube. Let the gas burn as long as possible, relighting as needed.
- 10) When all the wood has been heated, turn off the burner. Examine the liquid in the upright test tube in the beaker of water. Record your observations and questions your group has generated.
- 11) Examine the remains of the wood splints. Try burning some of this wood. Record your observations and questions your group has generated.

Part 2: Distillation of a liquid

- 1) Place a few boiling chips in the test tube with the liquid you have collected.
- 2) Use the apparatus setup shown in Figure 2 to boil off about half of the liquid. Make sure the rubber tube is all the way into the collecting test tube in the beaker of ice water.
- 3) Record your observations and questions your group has generated.
- 4) In this order, remove the rubber tube from the test tube in the beaker of water, then turn off the burner.
- 5) Compare the liquid you collected in the test tube in the beaker to the original liquid. Do they look the same? Record your observations and questions your group has generated.
- 6) Try mixing the liquids in the two test tubes. Record what happens.
- 7) Clean up.

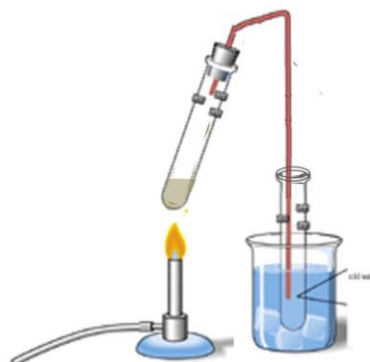


Figure 2

How is this activity related to my knowledge of science/chemistry? (Questions)

- 1) The best way to learn how things work or what they are made of, is to take them apart. Did you take wood apart?
- 2) How many different states of matter were produced in the process?
- 3) Did the wood melt?

- 4) Decomposition is the term given to the process of taking apart matter. Were the substances you collected present in the wood or did they form when heated?
- 5) Upon examination of the liquid in the condensing test tube, does it look like one liquid or more than one? Explain.
- 6) Mixtures may be separated by the process of distillation. What evidence indicated the dark liquid was a mixture?
- 7) What physical property did you use to determine if the liquid was a pure substance or a mixture?
- 8) Predict the result of recombining the liquids in both test tubes.
- 9) If you combine all the materials you collected, can you get the wood back? Explain.
- 10) You were able to burn the remaining wood in the test tube. What is the difference between burning the wood and heating the wood?
- 11) The gas produced upon the initial heating was not carbon dioxide or water. How did you know this?

How can I extend my learning with this activity? (Extensions)

- 1) Distill a mixture of cherry coke and water. You will enjoy the aroma during the process.
- 2) Research the process of the destructive distillation of wood. Explore the uses for the products of this process.

Observations and Questions

	Observations	Questions
Part 1		
#6		
#7		
#9		
#10		
Part 2		
#3		
#5		
#6		

Distillation of Wood

Teacher's Guide

Concepts:

- Experimentation
- Decomposition
- Distillation
- States of matter
- Mixtures

Background:

Questioning and experimentation are key tools of discovery. In this activity, students will repeat the experiment that sparked Ahmed Zewail's career in science. Wood is a common natural material that is all around and appears in one form. However, when heated it yields many different substances in several states of matter. It will serve as an opportunity to explore matter and its changes and generate many questions along the way. Working in groups will help stimulate the generation of questions. Ahmed Zewail was motivated by curiosity. Encourage the students to think like scientists throughout the activity, and then address their questions at the end. When new material is explored, we often find that we have more questions than answers.

Chemistry:

Distillation of wood is the process in which wood is heated (not burned) to form charcoal and vapors. The vapors condense in a cold collecting test tube to form a brownish liquid. This liquid is called pyroligneous acid. It is composed of a complex mixture of acetic acid, methyl alcohol, acetone and a number of other chemicals. Some methyl alcohol vapor is forced through the second glass bend and may be lit with a match. The remaining wood is charcoal.

Materials:

safety goggles	ice water
apron	burner
2 test tubes	striker
wood splints	rubber tube
1-hole stopper	glycerin
2-hole stopper	ring stand
2 glass bends	test tube clamp
beaker	boiling chips
matches	

Safety and Disposal:

- 1) Wear chemical splash goggles and a chemical resistant apron.
- 2) Keep the flame away from the rubber stopper and test tube clamp.
- 3) Use glycerin when attaching the rubber hose to the glass elbow.
- 4) Insert the rubber tubing all the way into the collecting test tube in the beaker of water.

- 5) Burn the remaining wood splints over the sink or a heat resistant pad.
- 6) Charred wood and ash may be disposed of in the trash.
- 7) Clear colorless liquid may be flushed down the sink.
- 8) The tarry dark liquid should be placed in a closed container and disposed of by an environmental agency.

Procedure:

NOTE: Students are encouraged to generate questions as they follow the prescribed procedure just as a scientist would do. If this activity is done later in the year when students have a good working knowledge of science equipment and laboratory techniques, the activity could be more open ended and the students could design their own procedure.

- 1) Prior to starting the activity, preassemble the stopper assemblies for parts 1 and 2. They may be kept for future use.
- 2) Have students follow the procedure in the student activity. Check their equipment setup before heating begins.
- 3) Use ice water in the condensing beaker.
- 4) The activity is divided into two parts. It may be completed in one day or two.
- 5) Follow the procedure described in the Student Activity.

Questions:

- 1) The best way to learn how things work or what they are made of, is to take them apart. Did you take wood apart?
Yes, the wood was not combined with oxygen during the heating.
- 2) How many different states of matter were produced in the process?
Three, liquid and gas and the new solid, charcoal.
- 3) Did the wood melt?
No, the wood decomposed producing liquids and gases.
- 4) Decomposition is the term given to the process of taking apart matter. Were these substances present in the wood or did they form when heated?
The products were present in the wood
- 5) 5) Upon examination of the dark liquid in the test tube, does it look like one liquid or more than one?
It appears to be one liquid.
- 6) What physical property did you use to determine if the liquid was a pure substance or a mixture?
Boiling point
- 7) Mixtures may be separated by the process of distillation. What evidence indicated the dark liquid was a mixture?
The condensed liquid was clear and colorless
- 8) Predict the result of recombining the liquids in both test tubes.
The original dark liquid will be present
- 9) If you combine all the materials you collected, can you get the wood back? Explain.
No, the wood was chemically taken apart and cannot be physically combined to form wood.

10) You were able to burn the remaining wood in the test tube. What is the difference between burning the wood and heating the wood?

Burning combines oxygen with the wood to form new substances. Heating breaks down the wood into its components.

11) The gas produced upon the initial heating was not carbon dioxide or water. How did you know this?

The gas was flammable. The gas produced was methanol vapor.

References:

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